Claims 1 to 11 were presented for examination. Claims 2, 3 and 4 were objected to under 35 USC 112(1). Claims 7, 8 and 9 were objected to under 35 USC 112(2). The proper antecedent words and spelling errors have been corrected as discussed in the telephone interview noted above.

Claims 1, 5, 6 and 8 to 11 were rejected under 35 USC 102 alleging that the primary reference Steere, Jr. (5,111,622) teaches every element and the mode of operation set forth in the claims. This ground(s) for rejection is in error and the alleged teaching of Steere, Jr. traversed for the reasons that follow.

Before discussing the distinctions in applicant's claims, a brief description of the teachings of the Steere, Jr. reference is needed. First, Steere, Jr. grinds the face of ingot 12 as partially shown in Fig. 5. The extended grinding wheel 28 is employed to grind the face 29 of ingot 12 by vertical movement shown by the unnumbered arrow. See column 6, lines 45 to 68. Next the spring 33 pulls rod 22 and grinding wheel 28 back into its Fig. 2 retracted position.

Next, "the ingot 12 may be indexed --- to move [12] into the plane of the saw blade 24." Thereafter, the spindle housing 15 is moved downward to slice a wafer from ingot 12.

Note the sequence of operation:

Move housing 15
Extend grinding wheel 28
Move grinding wheel 28 vertically up
Retract grinding wheel 28
Move the housing 15
Extend ingot 12 into saw blade 24
Move saw blade 24 vertically down

Nowhere in Steere, Jr., is the structure described as an "air-bearing" between spindle 16 and rod 32! See col. 4, lines 50 to 68. The path of the compressed fluid is in bore 17, thus, an unnumbered seal is shown to seal off air in inlet 43. See Figure 1 for actuating air!

Applicant is restricted to his apparatus claims 1 to 11. Claim 1 calls for "a coaxial spindle cutting saw for dicing wafers"! Steere, Jr. teaches "a slicing and grinding system"!

Claim 1 calls for a "coaxial spindle comprising a center spindle" and "a first cutting saw blade mounted on said center spindle". Steere, Jr. has a surface (disk shaped) grinding wheel! There is no way that a cutting saw blade can be mounted on the Steere, Jr. structure and none is shown or suggested. As a matter of fact the modification suggested by the Examiner will render Steere, Jr. inoperable and is a hindsight rejection in which the Examiner cited the applicant's claimed structure for a reference. The grounds for rejection are clearly improper and should be withdrawn!

Claim 1 as currently amended calls for two dicing saw blades for simultaneously dicing said wafer. Steere, Jr. does not teach this structure and cannot be modified to perform two cutting saw operations at the same time!

Claim 1 calls for positioning means for accurately positioning one of said cutting saw blades relative to the other cutting saw blade. Steere, Jr. has no such positioning means and clearly does not have two cutting saw blades. His grinder 28 is extended out or held withdrawn. It cannot dice a wafer as called for by claim 1.

The two spindle housings for claims 2 and 3 are provided in the prior art drawings and in the amended specification.

Claims 2 and 3 are rejected on Steere, Jr. and Ono. Ono shows "dual" cutting saws with side-by-side housings. This is not a dual spindle.

Claims 2 and 4 are rejected on Steere, Jr. and Azuma. Azuma shows dual housings and single spindles known as "a twin spindle cutting saw." This is not a dual spindle saw, but the two housing may be retrofitted with the present invention and double the production.

Ono's blades cut sequentially. Applicant can retrofit his novel coaxial cutting saw in Ono and provide four cutting blades!

Claim 7 is rejected on Steere, Jr. and Mueller (cited for a voice coil). The reference has nothing whatsoever to do with cutting saws and cannot be combined with the other cited references. The word voice coil is also in technical dictionaries but also not applicable to applicant's claims.

In summary, claim 1 as currently amended clearly distinguishes over Steere, Jr. and all known references. The rejection of claims 2 to 11 on Steere, Jr. on 35 USC 102 or 103 is also in error for reasons stated above. Clearly the dictionary (or technical dictionaries) explain what grinding means and it is not what a cutting saw does. Applicant traverses the allegation that grinding wheels are saw blades. The allegation that Steere, Jr. teaches "air bearings" is also traversed.

Claims 2 to 11 are dependent from allowable amended claim 1 and are in allowable form for issue.

Claims 1 to 11 are now in this application ready for issue as follows and a timely notice of allowance is requested.

Claim 1 (currently amended)

Claim 2 (currently amended)

Claim 3 (original)
Claim 4 (original)
Claim 5 (original)
Claim 6 (original)
Claim 7 (currently amended)
Claim 8 (currently amended)
Claim 9 (currently amended)
Claim 10 (original)
Claim 11 (original)

Respectfully submitted,

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The Z slider 29 supports a spindle housing 12 which supports a Y prime rail 46 on which is mounted a Y prime slider 39. The Y prime slider 39 supports an actuator arm 41 which in turn supports an air bearing coupling. It will be understood that the outer shaft 44 is preferably supported on an air bearing for slideable movement on the center shaft 45 and the coupling 47 also includes an air bearing which couples to the outer annular ring on the outer shaft 44. It will be understood that the slider 39 is programmed to move the outer shaft 44 which supports the inner hub 48 which comprises a blade portion 14. Thus, it will be understood that the inner blade 14 can be moved to flush engagement with the outer blade 14 so as to cut a wide street or accurately position so as to cut two adjacent streets on either side of a semiconductor device.

The hub-type blade 48 is basically a modification of prior art single piece hub-type blades and comprises a flat face hub portion 49, a lock nut portion 51. The adapter portion 52 permits the lock nut 51 to be flush mounted in against the flat face hub portion 49 so that the hub-type blades can be positioned flush to each other.

Refer now to Figure 5B showing an enlarged drawing in side or front elevation of the present invention coaxial dual spindle cutting saw showing two hub-type blades mounted on the coaxial spindles or shafts 44 and 45 with the rear or inboard saw blade 14 moveable by a voice coil assembly 57. There is shown a spindle housing 35 which is moveable in the Y direction and supports the frame of the voice coil assembly 57 which supports therein the electrical actuating coils 58. The coils 58 drive the outer moveable shaft 44 which supports the permanent magnets 59 in

the flux field of the actuating coils 58. Shown schematically at 53 is a spine or keyed system which allows linear motion but not relative rotational motion to the center shaft 45. It will be understood that regardless of the type of key or spine that is used, the outer moveable shaft 44 is preferably supported on an air bearing especially for high speed. However, the outer moveable shaft 44 could be supported on conventional bearings especially for low speed or singulation. Further, there is provided a water seal 54 and a water seal 55 to prevent cooling water from entering the system. A pressurized air chamber 56 may be provided to maintain an air flow at the seal 55 to guarantee that no water enters into the moving system.

It is understood that the voice coil assembly 57 moves in the Y direction with spindle housing 35 and has a Y prime linear movement as a result of the voice coil assembly moving the outer shaft 44 relative to the outer blade. Thus, it can be seen that the blade portion 14 of the modified hub 48 is capable of being moved into flush contact with each other. Further, the locking nut 51A on the inner hub is recessed in an annular recess 61 so that the flat face hub poption 49 is capable of moving into abutting relationship with other saw blade. The modified hub 48 is shown having a larger outer locking nut 51 and an adapter 52. In the preferred embodiment of the present invention the voice coil assembly 57 may be accurately positioned with an encoder 50 or a laser interferometer device RH as is known in the prior art.

Refer now to Figure 6 showing a modification of the cutting saw shown in Figure 5A and having a front saw blade 48 that is moveable by an actuating arm 41 mounted on

Further it will now be appreciated that the present invention coaxial spindle cutting saw housings and assembly may be retrofitted into saws of the type shown in Figures 1 to 2B as well as in single spindle saw environments. Thus, Figures 1 to 2B show two housings (stations) each with one saw blade which can be replaced with the present invention spindle housing etc. as second spindle housings in end-to-end or side-by-side arrangements. The number of cutting saw blades in the prior art are easily doubled by retrofitting the housings described in the prior art with the present invention housings.

WHAT IS CLAIMED IS:

1(Currently amended). A coaxial spindle cutting saw for dicing wafers and singulating substrates, comprising:

a spindle housing for mounting on a cutting saw;

a coaxial spindle mounted in said spindle housing for movement therewith,

said coaxial spindle comprising a center spindle having first mounting means for positioning a first cutting saw blade mounted on said center spindle,

said coaxial spindle further comprising an outer hollow spindle mounted on said center spindle for rotation therewith and for axial movement relative thereto,

second mounting means for positioning a second cutting saw blade on said outer hollow spindle,

a spindle drive motor coupled to said spindles for rotating both said center spindle and said outer hollow spindle together at the same rotational speed;

spindle positioning means coupled to one of said spindles for accurately positioning one of said cutting saw blades relative to the other cutting saw blade, and

whereby, said first cutting saw blade and said second cutting saw blade comprise two dicing saw blades for simultaneously dicing said wafer.

2. (Currently amended) A coaxial spindle cutting saw as set forth in claim 1 which futher includes a second housing mounted on said same cutting saw; and

four spindles in said two spindle housings for mounting four cutting saw blades for simultaneous cutting operations.

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7 (Curently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning means further includes a voice coil actuating means mounted on said spindle housing for positioning said outer spindle relative to said center spindle.

8 (Currently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said voice coil actuating means further includes a moveable actuating arm slideable relative to said spindle housing; and

an air-bearing coupling mounted on said actuating arm for movement of said outer hollow spindle.

9(Currently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning means futher includes a movable actuating arm mounted on said spindle housing; and

coupling means mounted on said actuating arm for movement of said outer hollow spindle.

The Z slider 29 supports a spindle housing 12 which supports a Y prime rail 46 on which is mounted a Y prime slider 39. The Y prime slider 39 supports an actuator arm 41 which in turn supports an air bearing coupling [49]. It will be understood that the outer shaft 44 is preferably supported on an air bearing for slideable movement on the center shaft 45 and the coupling 47 also includes an air bearing which couples to the outer annular ring on the outer shaft 44. It will be understood that the slider 39 is programmed to move the outer shaft 44 which supports the inner hub 48 which comprises a blade portion 14. Thus, it will be understood that the inner blade 14 can be moved to flush engagement with the outer blade 14 so as to cut a wide street or accurately position so as to cut two adjacent streets on either side of a semiconductor device.

The hub-type blade 48 is basically a modification of prior art single piece hub-type blades and comprises a flat face hub portion 49, a lock nut portion 51. The adapter portion 52 permits the lock nut 51 to be flush mounted in against the flat face hub portion 49 so that the hub-type blades can be positioned flush to each other.

Refer now to Figure 5B showing an enlarged drawing in side or front elevation of the present invention coaxial dual spindle cutting saw showing two hub-type blades mounted on the coaxial spindles or shafts 44 and 45 with the rear or inboard saw blade 14 moveable by a voice coil assembly 57. There is shown a spindle housing 35 which is moveable in the Y direction and supports the frame of the voice coil assembly 57 which supports therein the electrical actuating coils 58. The coils 58 drive the outer moveable shaft 44 which supports the permanent magnets 59 in

the flux field of the actuating coils 58. Shown schematically at 53 is a spine or keyed system which allows linear motion but not relative rotational motion to the center shaft 45. It will be understood that regardless of the type of key or spine that is used, the outer moveable shaft 44 is preferably supported on an air bearing especially for high speed. However, the outer moveable shaft 44 could be supported on conventional bearings especially for low speed or singulation. Further, there is provided a water seal 54 and a water seal 55 to prevent cooling water from entering the system. A pressurized air chamber 56 may be provided to maintain an air flow at the seal 55 to guarantee that no water enters into the moving system.

It is understood that the voice coil assembly 57 moves in the Y direction with spindle housing 35 and has a Y prime linear movement as a result of the voice coil assembly moving the outer shaft 44 relative to the outer blade. Thus, it can be seen that the blade portion 14 of the modified hub 48 is capable of being moved into flush contact with each other. Further, the locking nut 51A on the inner hub is recessed in an annular recess 61 so that the flat [flange] face hub portion 49 is capable of moving into abutting relationship with other saw blade. The modified hub 48 is shown having a larger outer locking nut 51 and an adapter 52. In the preferred embodiment of the present invention the voice coil assembly 57 may be accurately positioned with an encoder 50 or a laser interferometer device RH as is known in the prior art.

Refer now to Figure 6 showing a modification of the cutting saw shown in Figure 5A and having a front saw blade 48 that is moveable by an actuating arm 41 mounted on

Further it will now be appreciated that the present invention coaxial spindle cutting saw housings and assembly may be retrofitted into saws of the type shown in Figures 1 to 2B as well as in single spindle saw environments. Thus, Figures 1 to 2B show two housings (stations) each with one saw blade which can be replaced with the present invention spindle housing etc. as second spindle housings in end-to-end or side-by-side arrangements. The number of cutting saw blades in the prior art are easily doubled by retrofitting the housings described in the prior art with the present invention housings.

WHAT IS CLAIMED IS:

1(Currently amended). A coaxial spindle cutting saw for dicing wafers and singulating substrates, comprising:

a spindle housing for mounting on a cutting saw;

a coaxial spindle mounted in said spindle housing for movement therewith,

said coaxial spindle comprising a center spindle having first mounting means for positioning a first cutting saw blade mounted on said center spindle,

said coaxial spindle further comprising an outer hollow spindle mounted on said center spindle for rotation therewith and for axial movement relative thereto,

second mounting means for positioning a second cutting saw blade on said outer hollow spindle,

a spindle drive motor coupled to said spindles for rotating both said center spindle and said outer hollow spindle together at the same rotational speed; [and]

spindle positioning means coupled to one of said spindles for accurately positioning one of said cutting saw blades relative to the other cutting saw blade, and whereby, said first cutting saw blade and said second cutting saw blade comprise two dicing saw blades for simultaneously dicing said wafer.

2. (Currently amended) A coaxial spindle cutting saw as set forth in claim 1 which futher includes a second housing mounted on said same cutting saw; and

four spindles in said two spindle housings for mounting four cutting saw blades for simultaneous[ly] cutting operations.

7 (Curently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning [motor] means further includes a voice coil actuating means mounted on said spindle housing for positioning said outer spindle relative to said center spindle.

8 (Currently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said voice coil actuating means further includes a moveable actuating arm slideable relative to said spindle housing; and

an air-bearing coupling mounted on said actuating arm for movement of said outer hollow spindle.

9(Currently amended). A coaxial spindle cutting saw as set forth in claim 6 wherein said spindle positioning [motor] means futher includes a movable actuating arm mounted on said spindle housing; and

coupling means mounted on said actuating arm for movement of said outer hollow spindle.